Dr Percy
with the best wishes of
the author

INAUGURAL DISSERTATION

ON THE

RESPIRATORY SYSTEM OF NERVES,

CONSIDERED AS

THE VEHICLE OF GENERAL SYMPATHY.

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ON THE

RESPIRATORY SYSTEM OF NERVES,

CONSIDERED AS THE

VEHICLE OF GENERAL SYMPATHY;

SUBMITTED TO THE

Medical Faculty of the University of Edinburgh,

IN CONFORMITY WITH THE RULES FOR GRADUATION,

BY AUTHORITY OF THE

VERY REVEREND PRINCIPAL BAIRD,

AND WITH THE SANCTION OF THE

SENATUS ACADEMICUS.

BY

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CANDIDATE

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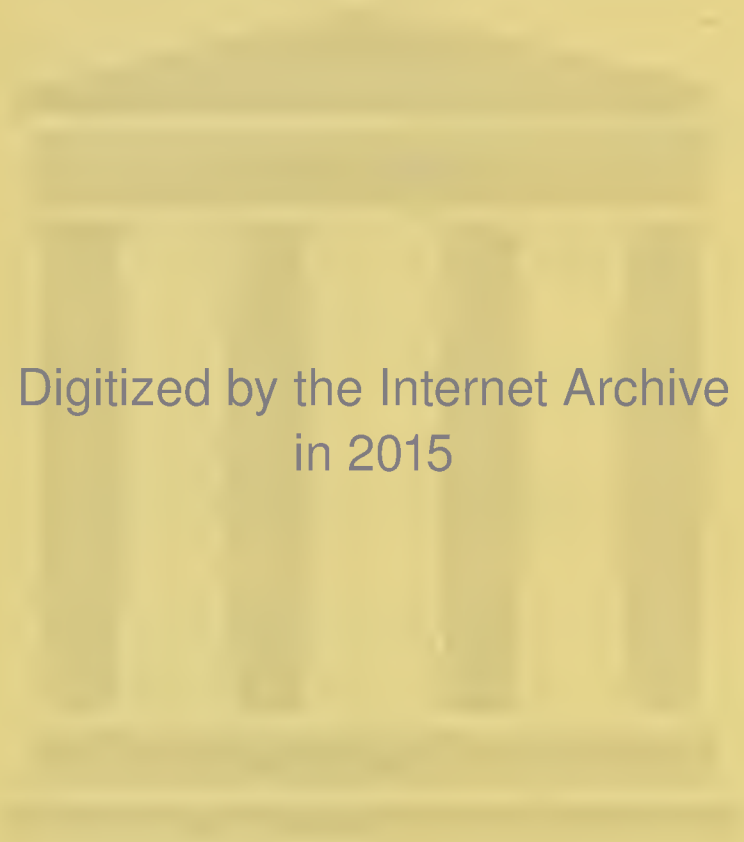

TO

SIR CHARLES BELL, K. G. H., F. R. SS. L. & E.

PROFESSOR OF SURGERY IN THE UNIVERSITY OF EDINBURGH,

&c. &c. &c.

AS A SMALL TESTIMONY OF RESPECT FOR

HIS VALUABLE DISCOVERIES,

EXTENSIVE ACQUIREMENTS,

AND

AS AN ACKNOWLEDGMENT OF HIS UNVARIED KINDNESS,

THIS ESSAY

IS, WITH PERMISSION, DEDICATED

BY

HIS ATTACHED FRIEND AND PUPIL,

THE AUTHOR.

CONTENTS.

ON THE

RESPIRATORY SYSTEM OF NERVES, &c.

CHAPTER I.

ON SYMPATHY.

Before entering upon the consideration of the evidence in favour of a Respiratory System of Nerves, it may be proper to offer a few observations upon the subject of Sympathy in general.

Every organ in the body is so connected with all the rest, that when a particular impression is made upon one, any other may be sensibly affected by it. While all organs seem to be thus united, some, however, are much more intimately connected, and constantly reciprocate ordinary impressions. The organs which are probably endowed with the most extensive sympathetic connections are the brain and the stomach. Impressions upon either of these speedily affect the whole frame. The impression made upon the

stomach by the reception of food immediately increases the vigour of the muscular system, so much that the individual is capable of much greater exertions than before, and when the stomach suffers under any disease almost all the other organs sympathize. The impressions transmitted from the brain, considered as the organ of the mind, are very numerous, and so powerful as to affect almost every part of the body, even those, such as the hair, which are usually considered as beyond the pale of organic influences.* The glandular structures seem to be peculiarly under the influence of the mental emotions, as the increased, diminished, or altered secretion of milk, bile, urine, or gastric juice, which take place when the person is agitated by some particular passion sufficiently evinces. Many attempts have been made to arrange systematically the various kinds of sympathetic action.† The only division, however,

* "My head is grey, but not with years,
Nor grew it white
In a single night,
As men's have done from sudden fears."
BYRON.

† M. Piorry has proposed the following:—
1st, Sensation in one organ transferred to some other.
2d, Weak sensation in the first and strong in the second.
3d, Sensation in the first causing movement in second.

which we shall here notice, is, into what has been called active and passive sympathy. Thus, of all the organs of the body, the heart is that which sympathizes most readily with every other, it is affected by all the passions, and by a morbid impression on any part of the system; but readily as it is itself excited by impressions on distant organs, it does not appear to affect other parts except by, what may be called, the mechanical result of its own impressions, for the flush of the surface in joy seems to arise rather from the fuller and more frequent contraction of the heart, than from any sympathetic connection between the parts. The heart then is said to be endowed with passive, the brain with active sympathy. We often observe little relation between the intensity of the *sensation* produced by an impression and the sympathetic action which follows. Thus, a slight impression upon the fauces will produce vomiting, while a more severe one will only give rise to pain. There is, however, a perfect consistency in this as in all the other operations of the animal economy, and a particular

4th, Motion in first causing motion in second.

5th, Alteration in the elementary function of a part followed by change in the sensation of another.

6th, Transient alteration in first causing profound disturbance in second.

character of impression is required to be made on one organ to produce a sympathetic action in another.

Many organs act upon one another reciprocally, while in some the stimulus is conveyed only in one direction. In respiration for example, the impression at the lungs communicates a stimulus to the muscles of inspiration and expiration, while they on their part are incapable of returning any.

Respiration affords a striking illustration of M. Piorry's third class of sympathetic actions, viz. "sensation in (or impression on) one part causing movement in another;" so remarkable, indeed, that from it has been borrowed the name of a system of nerves which seems devoted to convey general sympathy. The name itself is of little consequence: indeed, Sir C. Bell when he gave it, observed, that his object was rather to rouse the attention of the profession, when they heard of respiratory nerves in the eye, stomach, and heart, to inquire into the nature of the investigations which led him to give them such a designation, than to intimate that the system was merely confined to organs connected with respiration.

CHAPTER II.

ON THE VEHICLE OE SYMPATHY.

We now come to consider the prevalent opinions "on the mode by which a stimulus applied to one organ acts upon another at a distance;" or "how one part sympathizes with another?" The only theories upon this subject which we shall here consider are, 1*st*, That it is not by means of a special nervous communication, but by means of sensation, that sympathetic actions take place; 2*d*, That it is by the ganglionic system of nerves; 3*d*, That it is in a great measure by the reflex action propagated along the nerves of sensation and voluntary motion.

The first opinion was held by Whyte, Haller, and Monro, and has been more recently adopted, and powerfully advocated, by Professor Alison,* who observes, in his "Outlines of Physiology," "That the immediate cause of such changes (sympathetic actions) is truly a mental sensation,

* Med. Chirurg. Trans. vol. ii.

which always intervenes between the impression produced on one part and the change which follows in another; or perhaps more correctly, is some action in the nervous system which is attended, and makes itself known, by a sensation, and that the two parts sympathize only so far as the sensation which affects the one is excitable by an impression on the other." Here there are two propositions made, with neither of which we feel ourselves at liberty to agree. The first is, that, in all cases of sympathetic actions, mental sensation is present; and the second, that its presence explains their occurrence. The second clause, viz. " that two parts sympathize only in so far as the sensation which affects the one is excitable by the impression on the other," seems no more than a statement of the fact, and leaves unanswered the question, " In what way does an impression on one part excite sensation in another?" That mental sensation is always present during the occurrence of such sympathetic actions, seems highly doubtful; we know at least that some, for instance respiration, will take place in anencephalous fœtuses,* in animals after having been stunned by a blow,† after the brain has

* Lawrence, Med. Chirurg. Trans. vol. v.

† M. Hall, Lectures on the Nervous System, p. 17.

been removed either accidentally in man,* or experimentally in the lower animals,† and in coma, apoplexy, and profound sleep; in which conditions it seems scarcely possible that sensation, at least *mental* sensation, could continue. So strong did these objections appear to Dr Henry, that, although he agrees in the main with Dr Alison, yet he observes,‡ "Dr Alison has failed to shew that the essential acts of respiration depend upon a sensation."

But even were it established that sensation is always present, it would remain to be shewn in what way except as exciting volition it could effect sympathetic action; as Dr M. Hall § observes, "How can sensation act in producing motion except through the medium of volition? It is impossible."

THE GANGLIONIC SYSTEM.

The first question that meets us in the consideration of this part of the subject is, What is

* Brachet says, "I once saw a wretch whose brain was blown off by the explosion of a fire arm, nothing being left but the cerebellum and medulla oblongata, and yet he continued to breathe for half an hour. Brachet, Reserch. Experiment. sur les Fonct. du Syst. Nerv. Gangl. 1830, p. 81.

† Legallois.

‡ Report of Third Meeting of British Association.

§ Dr M. Hall's Lectures on the Nervous System, p. 52.

meant by the ganglionic system? Is it a simple or a compound system? If compound, which of its functions are essentially its own, and which derivative?

There is little difficulty in answering the first of these questions. The ganglionic system is compound. The researches of Willis, Lobstein, and Swan, have sufficiently established this. It unites largely with the cerebro-spinal nerves, and while it no doubt imparts some of its filaments to them, it likewise receives filaments from them. The compound nature of this system is farther shewn in the properties of the parts which it supplies. For instance, in many internal organs, and in the testicle, there is an obscure sensation, although no cerebro-spinal nerves can be traced into those parts; and yet it is manifest that sensibility * is probably derived from the spinal cord alone. It is far more consistent with our knowledge of the uniformity and simplicity of the animal frame, to believe that the ganglionic nerves, by their inosculation with the cerebro-spinal, receive some of their sensitive filaments, and convey them to the testicle, than that the ganglionic

* By sensibility we always mean the property of giving rise to *sensation* of which the mind may be conscious, not the property of displaying action when stimulated.

nerves acquire the power of communicating sensibility to certain organs, while they themselves, where most concentrated, exhibit no such property.

Besides, as an additional argument that the ganglionic nerves possess this power only in virtue of their connexion, we would observe, that division of the spinal column above the sacral nerves destroys sensation in the testicle; proving that the spinal column is the real source of sensibility even to parts apparently supplied only by ganglionic nerves.

We have, moreover, nerves of sensation, and it is unlike the consistency of Nature to endow, in certain situations only, a particular set of nerves with a function, for the performance of which a complete system is already provided.

From these, and many other arguments which might be adduced, it is clear that the ganglionic system, besides its own proper essential function, derives from the cerebro-spinal the property of communicating sensibility; and as we can thus establish that it derives one function from the cerebro-spinal system, there will be a presumption of its acquiring another, if we can shew that that other, which it seems to possess in its own right, is manifested in much greater perfection

in some of the spinal nerves. The function we allude to is the power of transmitting sympathy. If our conclusion be admitted, which we think it must, that the ganglionic nerves endow parts with sensibility only in virtue of their connexion with the cerebro-spinal, let us suppose, for the sake of illustration, such an arrangement as this. Instead of the spinal nerves leaving the spinal column disconnectedly, and proceeding in individual branches to different organs, let us imagine that the moment they left the cord they became incorporated with the ganglionic system, and diffused with it throughout all the frame; is it not evident that, if such were the case, it would be extremely difficult to prove that the ganglionic system was not *essentially* the system of sensation, and yet manifestly the assertion would have been as true as under the present arrangement. But if, in one or two organs peculiarly endowed with sensibility, we could have traced nerves coming directly from the spinal cord, and found sensibility much impaired by division of these nerves, we might possibly have arrived at a just conclusion, and believed that, as in one organ where the ganglionic and spinal nerves were distinct, sensation depended on the spinal nerves, so in all the organs to which the ganglionic supplied

sensibility, they supplied it only in virtue of their connexion with the spinal nerves,—we might have come to this just conclusion, but we never could have established it by demonstration, as can be done in the existing arrangement. Such is exactly the state of the question, as to whether the ganglionic are sympathetic from their own essential constitution, or merely from their connexion.

Although it may be impossible to demonstrate that the ganglionic system is not the vehicle of sympathy and passion, we can at least shew that it is not the *only* vehicle, and adduce the following arguments to render it probable that it is not the vehicle at all.

1*st*, Division of these nerves does not arrest sympathetic actions.

2*d*, The division of the nerves of another system greatly impairs the performance of these actions.

3*d*, Crushing the centre where the nerves of this other system meet, instantly arrests all sympathetic action.

4*th*, If these nerves be for conveying sympathy, there seems no necessity for the distribution of other nerves in organs excitable by sympathy alone, not by volition, and not endowed with sensibility.

1*st*, The experiments of Dupuy* prove, that the cervical ganglia may be divided without seriously affecting respiration, and that irritating them produces little agitation. In one case, indeed, asphyxia was threatened by cutting these nerves; but as it was averted by opening the trachea, it is probable that the par vagum was wounded in the operation, so as to produce spasm of the glottis.

Brachet† and Sir A. Cooper‡ also found, that, after the division of these nerves in the neck, respiration and other sympathetic actions continued.

2*d*, It would be anticipating another part of our subject, were we here to enter fully into the proof of this assertion, that division of other nerves impairs sympathetic action. It will be sufficient to observe, that section of the par vagum produces great perturbation of the respira-

* Journal de Medecine et Chirurg., vol. xxxvii. p. 340.

† Reserch. Experiment. (op. cit.)

‡ Sir A. Cooper included the ganglionic nerves on both sides of the neck in a ligature in two rabbits: great uneasiness followed the operation; this, however, soon subsided: one was killed seven days after. The nerve on one side was quite divided, on the other partially, by ulceration. The other rabbit was still alive.—Guy's Hospital Reports, vol. i. p. 470.

tory organs at the time, and ultimately asphyxia,* and that after division of the seventh pair, sprinkling water on the face no longer excited the respiratory muscles.†

3*d*, If the ganglionic nerves be the vehicle of sympathy, why should all sympathetic action be instantly suspended when the medulla oblongata is crushed ?‡ Their function does not seem to be interfered with in this operation; and, if they had the power of transmitting sympathy at any time, surely in such an exigency that power would be manifested.

4*th*, In many organs, as the heart, we find a supply of ganglionic, and also of nerves from another source. The heart seems not to be endowed with sensibility, and acts certainly involuntarily. It is only influenced in its action by sympathy and passion. If the ganglionic nerves can convey this, for what purpose do we find the par vagum distributed there ?

* Brachet and Milne Edwards, Archives Generales, tom. viii.; also Brachet, op. cit.

† Bell on the Nerves.

‡ It is usually said, that crushing the medulla oblongata produces death, by stopping respiration. But we know that respiration may be arrested for minutes even, without any such effect; and we conceive it operates by acting on the centre of all sympathetic actions, and therefore on all the vital organs.

5th, In some cases of fever,* perspiration is frequently observed to bedew only one side of the body, the mesial line being the boundary. Now if this be, as we may presume it is, a sympathetic affection—for we cannot account for it by any local influence to which that side is exposed—it follows, that the nerves which convey this sympathy are symmetrically disposed, which we know not to be the case with the ganglionic.

From these arguments we conclude, that the proper ganglionic system is not fitted for the transmission of sympathy.

REFLEX ACTION.

We now come to consider the doctrine of reflex action or the *excito-motory theory*, which has of late been brought so much into notice by Dr Marshall Hall and his followers.

It has been long known, that when a sensific nerve is irritated, the muscle to which this nerve is distributed contracts.† Hence, it has been argued, result sympathetic motions, for when any

* This was frequently pointed out by Dr Alison to those who enjoyed the privilege of accompanying him during his clinical visits.

† Whytt.

part is irritated, suppose the Schneiderian membrane, the sensific nerve of the part, in this instance the nasal branch of the fifth conveys an irritation to the spinal cord, from which a certain reflex action is propagated along the phrenic, and the diaphragm contracts.

The advocates of this theory have presumed, from a limited number of observations, that the *reflected* action is of a definite character, and that the combined movements which result indicate at once a knowledge of the source of the irritation, and of the means by which it is to be removed. Thus, when Magendie pulled the whiskers of a rabbit after the removal of the brain, the fore-feet were observed to rise, as if for the purpose of removing the offending body from its face. Nay, some* have even stated, that when the sole of the foot of a rabbit similarly prepared, was pinched, there was a combined action of the muscles, as in walking or running, as if the dead animal were cheated into the belief that its feet were upon the ground, and that it would be well to fly from the scene of persecution.†

Now, even admitting the reflex action to occur

* Grainger on the Spinal Cord.

† See Some Observations by Curling in a Prize Essay on Tetanus, 1836, p. 95.

to the full extent that the advocates of this doctrine have described, we conceive, that, although it might account for a sort of instinctive motion without an action in the brain, yet is quite incompetent to account for sympathetic action in general, for the following reasons :—

In the *first* place, it presumes a stimulus propagated along a sensiferous nerve in every case of sympathetic action. This, however, is doubtful at the least, as the most active sympathies originate in organs very sparingly supplied with sensific nerves: for example, in the lungs, a part slightly sensitive, active sympathetic action originates.

In the *second* place, this theory, although it may account for sympathetic *motion*, cannot account for sympathetic *action without motion* in organs incapable of motion, and therefore not supplied with excito-motory nerves.

In the *third* place, sympathetic actions of muscles take place in conditions of the system,* which would, under reflex action, be impossible,

* If it be urged that each portion of the spinal cord acts independently of its connections, Why, on the division of the cord in the back, should there be incapacity to void urine? Why should not the sensation of the bladder still remain, and, by a reflex action, call into operation the muscles of that viscus?

when there is not that integrity of the spinal cord which is indispensable for their production. There is a case related by Brachet,* of a man affected with paraplegia of the lower half of his body, begetting children. In this case, there was no sensation in the genital organs to give rise to the first link in the chain of reflex action.

Lastly, Sympathetic actions do not correspond to the intensity, but to the peculiar nature, of the sensation. Now, in reflex action, the secondary motion should have direct relation to the *intensity* of the irritation, and to that alone, and cutting as well as tickling the fauces, should induce vomiting.

But the whole theory of reflex action,† as occurring in such a definite and combined arrangement of muscular motion, as to produce phenomena at all resembling those which sympathy creates, seems founded on greatly exaggerated appearances. For in a great many cases in which the reflex actions displayed themselves, their combinations seemed wholly fortuitous, as in those

* Op. cit. 238.

† These motions seem sufficiently explained by the distribution of the nerves through the muscles, in such a manner as to fit them for exciting associated movements. (See Bell's Bridgewater Treatise.)

where passing a catheter in a paralytic, produced retraction of the legs.* How could such a retraction at all tend to remove the catheter from the urethra?

* See a case in Edin. Med. and Surg. Journal, No. 132, p. 33; also Mayo's Pathology, p. 154; and Grainger on the Spinal Cord.

CHAPTER III.

RESPIRATORY SYSTEM.

We now come to consider the direct evidence for the existence of a system of Nerves for the conveyance of Sympathy and Passion, and as we have already established that it is not the ganglionic, when we shall have shewn that it is distinct from the system of voluntary motion and sensation, its admission to the rank of a separate system must follow; and nothing more will remain but the consideration of the individual nerves of which it consists.

If the nerves, which we suppose to constitute this particular system, be but members of the more general one of voluntary motion and sensation, we should expect to find that diseases which affected the latter would likewise involve the former. This, however, seems in general not to be the case.

1*st*, In Tetanus we frequently find the whole of the voluntary muscles in a state of violent spasm, while respiration is unaffected, till towards the

termination of the disease, and then more by mental agitation than bodily affection.* When the respiratory muscles are affected, the spasms are most conspicuous in all the muscles of this system, and death speedily ensues.†

In Paralysis we continually find perfect palsy of all the muscles of voluntary motion with loss of sensibility, and yet respiration unimpeded. Bostock‡ has related a case of the most perfect palsy of voluntary motion, so that a sort of rigidity was assumed by the body in whatever posture it was placed. Articulation, deglutition, and all voluntary motions were utterly extinct, yet respiration continued unimpeded, and, indeed, so perfect, that he could cough although he could not use his abdominal muscles to assist in the evacuation of his bowels.

Indeed, not only do the ordinary muscles of respiration retain their power when the voluntary have wholly lost theirs, but even those which are usually wholly voluntary, although no longer affected by volition, are still excited by sympathy (vide p. 35). In coma, likewise, as we have already seen, both when occurring in man, and when

* Trnka de Tetano.

† Curling's Essay on Tetanus.

‡ Med. Chirurg. Transac. vol. ix. p. 1.

artificially produced in animals, respiration continues, although sensibility be quite lost.*

In these and many cases we find respiration, which we take merely as an example of sympathetic action continuing after the nerves of voluntary motion and sensation have either ceased to convey any stimulus, or are so perturbed in function as to excite to morbid action all the voluntary muscles.

We have shewn that the stimulus of sympathy is not conveyed by the ganglionic; so that no other alternative remains except either to believe that it is not conveyed by the nerves at all, or that there exists a set of nerves independent of the system of voluntary motion and sensation besides the ganglionic.

This system was discovered by Sir C. Bell, and named the Respiratory, as he thought it was confined to the respiratory organs and their dependants.

This supposition, however, involves us in the difficulty so triumphantly announced by its opponents. Why should there be a system for res-

* See experiments by Dr J. Reid, to which we shall have occasion to refer more particularly afterwards, in the Edinburgh Med. and Surg. Journal, No. 134.

piration and not for other sympathetic actions likewise, for fæcification even? say they. From this difficulty it is, however, rescued by the more extensive view taken of it by the late lamented Dr Fletcher, who conceived and rendered it probable by various arguments, that it is universally distributed, and is indeed the vehicle of sympathy and passion throughout the system. To Sir C. Bell, however, remains the merit of the discovery; and it was but fitting, that being the first to render us experimentally acquainted with the systems of voluntary motion and sensation, he should complete his labours by pointing out the link by which the animal system, with its passions and emotions, was bound to the organic one which without it would be as passive as a plant.*

This system he supposed to consist of the pathetic, facial, pneumogastric, glossopharyngeal, spinal accessory, phrenic, and external respiratory: and he has described them as arising from a tract, "which," he observes, "may be traced ascending behind the corpus olivare towards the corpora quadrigemina; while, on the other hand, it may be seen descending a little way between

* "What is an animal but a plant," asks Dr Brachet, "when we have removed the brain and spinal column?"

the columns of motion and sensation, to which it soon becomes united."*

The existence of such a tract is called in question by many anatomists, but as it is a point that rests solely on anatomical demonstration, it is impossible to consider it here, so we shall at once proceed to weigh the evidence, for each of the nerves individually being endowed with the power of transmitting sympathy, and therefore of holding the place here assigned them. The first (we shall consider) both on account of its importance, and the strength of evidence in its favour is the

PAR VAGUM.

This nerve is very early met with in the animal kingdom : in some species it is distributed almost universally throughout the system, frequently supplying very abundantly organs not capable of voluntary motion, and receiving from other sources a large supply of sensitive nerves.

In the sphynx ligustri, according to Newport,†

* Bell on the Nerves, 1836.

† Newport, Philosoph. Transact. (1832). There is at present a controversy going on in the periodical papers about Newport's statements here referred to, but it seems rather to question their originality than their truth.

there is a nerve which corresponds to the par vagum: it arises from a distinct ganglion, and is distributed upon the stomach and œsophagus.

In fishes this nerve is very large; in some, as the lamprey, it is said, to be three times as great as the spinal cord.* It divides into three branches, the first is distributed on the respiratory organs below the head, the second on the neighbouring muscles, and the third "proceeds directly outwards, and then runs along the side of the body, forming a lateral line, visible externally; an arrangement of which the accessory in man seems to form a repetition."†

This is well worthy of observation, and we shall find many other examples of the convertible character of the nerves of this system as we proceed. In fishes endowed with electric organs, as the torpedo and silurus, these organs, besides receiving a large number of sensific nerves from the fifth pair, are very largely supplied from the par vagum, and Spallanzani found that cutting these nerves disabled the organs. Now, as the action of the organ seems rather excitable by passion than volition, it is a strong confirmation of this doctrine, finding it here the instrument in

* Desmoulins and Magendie.

† Carus' Comparative Anatomy, vol. i. p. 245.

the production of one of the most striking manifestations of emotion.* The medium in which fishes respire seems to require a greater nervous energy, to enable them to overcome the obstacles to respiration, than is required by those tribes which respire in air; accordingly this nerve is said to be larger in the aquatic than in the land tortoise†.

In reptiles this nerve is in general not large, the branch which supplies the mouth, however, the most active organ in their respiration, is well developed.‡ In serpents the par vagum, after supplying the larynx, joins the inferior maxillary.§ Is this arrangement to convey the stimulus of passion to the poison bag?

The reptiles do not present many striking manifestations of the effects of passion on the sys-

* The power of giving an electric shock is analogous to the power which some animals, such as the skunk and cuttle-fish, have of voiding, when pursued, a copious secretion, either so fœtid as to prevent further pursuit, or of such a deep colour as to conceal them from their enemies. These secretions, we must believe, are, like others, not influenced by volition, but strongly influenced by the passions; in the instances above mentioned by the passion of fear. In these animals the effect of fear is turned into the means of security, while in man it is a source of annoyance, as in the diarrhœa, copious perspiration and flow of urine, which frequently attends sudden trepidation.

† Serres, Anatomie Comparatif. ‡ Carus.

§ Desmoulins and Magendie.

tem, except the change of colour in the chameleon, and in one or two other examples.*

In birds and mammalia the par vagum is distributed upon the larynx, trachea, œsophagus, stomach, lungs, and heart, and becomes intimately connected with the great ganglionic nerve: It is from this connexion that that nerve seems to derive its power of transmitting sympathy, as we have reason to believe, that, attaching itself to the bloodvessels, wherever they carry blood, that is to all vital organs, it likewise bears, inseparably connected with itself, filaments of this nerve.

We shall now proceed to illustrate, from experiments, that whatever be the other functions of this nerve, and that they are numerous, we are far from denying, it certainly must possess the power of transmitting sympathy. The part upon which this nerve is very largely distributed, viz. the stomach, is perhaps more abundantly endowed with sympathies than any other; a blow over it doubles up the boxer, and if more severe, is instantly fatal; the "coup de grace" to a man broken on the wheel is a blow on the stomach.* Here poisons, for the most part, take effect in some cases, almost instantaneously.

* Fletcher. † C. Bell.

Experiments prove that irritation of the par vagum in the neck induces an action of distant parts. Cruveillier found coughing caused by it; and Mr Broughton* that when this nerve was compressed, first an act of deglutition took place, and then an attempt to cough; and, in a case in which Sir A. Cooper wounded it in tying the carotid artery, frequent violent fits of coughing followed.†

After cutting this nerve the function of the stomach, on which it is so largely distributed, is immediately arrested, and that of the lungs so much impaired that the animal heat decreases, and the venous blood does not undergo the usual changes in passing through them.‡ It was found, however, that on irritating the cut extremity,

* Fourth Report of British Association.

† The case is as follows:—'A woman was brought into the hospital with an aneurism of the carotid artery; the tumour extended so low that there was great doubts whether there was sufficient room between it and the clavicle to introduce a ligature. However, the operation was successfully performed, the ligature was passed round and secured. The moment, however, that she rose from the chair on which she sat during the operation, she was seized with a violent fit of coughing, so violent that Sir Astley thought that it would have terminated her existence. The woman died, and on dissection the inflammation was found to have extended *along the par vagum* as far as the base of the skull." Medical Chirurgical Transactions, vol. i.

‡ Experiments of Sir A. Cooper, Guy's Hospital Reports. vol. i. p. 469.

either with galvanism or mechanically, the work of digestion was again carried on.*

These experiments prove that the par vagum transmits a stimulus to the stomach: the function of the stomach we know is not influenced by the stimulus of volition, but is powerfully influenced by that of sympathy and emotion, as the total loss of appetite on hearing bad news, or the rejection of food taken into the stomach, when its revolting character is discovered,† sufficiently evince. So that, as this nerve is adapted to convey some stimulus, and as sympathy is the only one, conveyable by nerves, that arrives at the stomach, it is manifest that sympathy is the only one which it can convey.

The influence of some poisons on the system, when administered by the mouth, is arrested by the division of this nerve.‡ We cannot here enter into the arguments which tend to prove that poisons do not in general act by absorption, but

* Brachet and Milne Edwards, Archives Generales, tom. vii. p. 195.

† A gentleman, fond of practical jokes, feasted his friends upon puppies variously disguised,—they praised the dishes, and asked the receipt: Some hours afterwards he told them what they had eaten, and one and all were seized with violent vomiting.

‡ Dupuy gave twenty-four grains of nux vomica to a dog, then cut the branches of the par vagum going to the stomach, and found that it lived twenty-four days after it. Experiment Symp. Jour. de Med. et Chirurg. vol. xxxvii. p. 359.

directly through the medium of the nerves, we must assume it as admitted, and recognise the fact just mentioned as another strong confirmation of the par vagum being the medium of sympathy, for how else could its division arrest the sympathetic action of the poison ?

It has also been observed that the violent disturbance of the heart's action, which usually follows the crushing of the brain, did not take place after this nerve was divided.*

Whatever influence the brain can exert over the heart must be exerted through this nerve. The only influence we are aware of its exerting is by sympathy and passion. This influence then must be conveyed by the par vagum.†

* Dr Reid observes. " Two rabbits were killed by crushing the brain extensively and suddenly by blows of a hammer. In one of these a portion of each of the pneumogastrics above the origin of the superior laryngeals had been removed. On exposing the heart of the rabbit in which the nerves were left entire, which was done as expeditiously as possible, these contractions of the heart were extremely rapid and very feeble. On exposing the heart of the animal, in which the nerves had been previously cut, which was also done immediately after the brain had been crushed, the action of heart was evidently much slower and more vigorous than in the other animal. The comparative experiment was again repeated with the same results. In other two rabbits he made the same observation. (Op. Cit. 49 p.) Brachet observed the fact likewise, and notices it in his Reserch. Experiment. between p. 109 and p. 119.

† Col. Tounsends seems to be the only case of volition acting

From all these arguments we feel ourselves justified in concluding, that the par vagum, besides its other functions, is a nerve of sympathy and passion, and is, therefore, entitled to a place among the respiratory nerves.

THE GLOSSOPHARYNGEAL.

We need not enter into any lengthened detail of the comparative anatomy of this nerve, as it would not contribute to the present argument. We may observe, however, that in fish it seems a nerve conducive to motion, probably sympathetic, as it is distributed on the muscular appendages of the gills, and when it is irritated these immediately contract.*

Physiologists are at present occupied in attempting to determine the function of this nerve by experiment. The opinions held are very various. Some, as Panizza, Alcock,† Broughton,‡ and M. Hall, consider it as contributing to the function of taste, while my friend, Dr John Reid,

on the heart, and in his case even it is more probable that it was by a vivid excitement of some emotion called up by a voluntary exercise of imagination, as players have frequently been carried away in a dead faint at a fainting scene, than by the direct influence of the will that he affected his object.

* Swan's Comparative Anatomy.

† Dublin Journal, vol. x. p. 256.

‡ Edin. Med. and Surg. Jour. vol. iv. p. 679.

in a very elaborate essay,* remarkable for the minuteness with which are detailed experiments, in themselves no less remarkable for the care and accuracy with which they were performed, concludes that it is a nerve of sensation.

In these experiments, he found that indications of suffering were generally, though not invariably, given when the nerve was irritated, attended with twitching of the muscles of the face and action of the pharynx; that these muscular contractions were produced as readily by irritating the proximal extremity of the nerve after its division as when it remained entire.

These appearances might all be easily explained on the supposition of this being a sensific and respiratory nerve; the twitching of the face being produced by the irritation conveyed along the portio dura.

However, another set of experiments seem to prove, that deglutition is not impaired by the section of these nerves on both sides, and offer a very serious objection to our receiving this as a respiratory nerve. It may indeed be urged, that, in these animals, deglutition may be more of a voluntary process than in man, and unless the experiment had been tried of producing a coma-

* Edin. Med. and Surg. Journal, No. 134.

tose state before putting the morsel within the range of the muscles of deglutition, the other experiments are not wholly conclusive.

The objection, however, still remains so serious, that, until there is more evidence collected in favour of this nerve being respiratory, we must postpone its admission into this system, (which we do the more readily, as these parts may derive from the par vagum a supply of respiratory nerves adequate for the sympathetic actions which they display).

THE SPINAL ACCESSORY.

Among the inferior animals, this nerve is only met with in quadrupeds, and is wanting even in some of them; in the camel, for example: the reason for which seems to be, that, in this animal, the neck is moved by a number of short muscles, and is not provided with any long one corresponding to the sterno-mastoid.

The origin of this nerve is so peculiar as to demand particular attention.

It arises between the ligamentum denticulatum and the posterior roots of the spinal nerves,* and has not, like the other regular nerves, any

* Bellengeri de Medulla Spinali.

connection with the grey matter of the spinal cord.* If the views of those anatomists and physiologists, who consider all nervous energy as generated in the grey matter of the spinal column and brain, be correct, and that volition in the brain only excites to action the spinal cord, by which is propagated that stimulus which causes the muscles to contract,—if this be correct, it is remarkable that this nerve should have no connexion with grey matter, and is in favour of the opinion which considers it adapted merely to transmit sympathetic influence from one organ to another.†

The experiments upon this nerve are contradictory in their results; for while Shaw‡ found that, after its division in an ass, although the voluntary motions of the shoulder were not impaired, yet that they did not rise as before when suffocation was threatened by cutting the par vagum. Dr Reid,§ on the other hand, found, that in two dogs and one cat on which he expe-

* Lobstein de Nerv. Spin. ad Par Vag. Acces. in Sandifort. Thesaur. Dissert.

† This view was taken by Malpighi, Willis, Vieussens, and Gall and Spurzheim; the two last considered the grey the matrix of the white.

‡ Edin. Med. and Surg. Journal, vol. xlix.

§ Op. cit. p. 62.

rimented, after the division of the nerve on one side, the sterno-mastoid of that side contracted synchronously with the muscles of respiration, although the animal had been reduced to a state of coma by prussic acid, so that no voluntary effort could be made; which experiments, although they shew that, in these animals, the spinal accessory is not the only respiratory nerve, as plainly prove that they must have some supply of respiratory filaments; for, as Dr Reid observed, "it was impossible they could make a voluntary effort,"—how else, then, but by means of this system of nerves, could these muscles be brought to act in unison with the other respiratory organs?

There are some very remarkable cases of palsy of the muscles supplied by this nerve in all voluntary motions, and their action during forced respiration. As the following: "A man having complete hemiplegia, the side of the face relaxed, the arm hanging down powerless, and the leg dragged in walking, some trouble was taken to make him raise his shoulders: he could only do it by bending his spine, and weighing up the shoulder of the paralysed side; but on setting him fairly in front, and asking him to make a full inspiration, the shoulders were elevated at

the same time that the nostrils were in motion. The facial and spinal accessory were entire, and although the regular system of nerves refused to act, the sterno-mastoid and trapezius partook of their share in respiration."* A somewhat similar case is related by Shaw.

Stromeyer,† after having examined this system of muscles with great attention, has come to the conclusion " that the voluntary motion of the serratus (a muscle closely connected in respiration with the trapezius) is highly doubtful. " After repeated observations in muscular men," he observes, " I am inclined to believe that, in the motion of the shoulder-blade, this muscle is wholly passive."

He conceives that paralysis of the spinal accessory is the cause of many lateral curvatures: from the want of antagonism to the diaphragm, which the sterno-mastoid and trapezius usually afford, that muscle acts upon the ribs of one side, flattening that side of the chest. If this view be adopted, the distortions of the face which so frequently attend curvature, may arise from the sympathetic connexion between the muscles of

* Bell on the Nerves.

† On Paralysis of Muscles of Inspiration. British and Foreign Med. Review, Jan. 1838.

the face, and those supplied by the spinal accessory or external respiratory. That this is really so, is rendered probable by the fact stated by Stromeyer, that he always found that, when these muscles were restored to action, the distortion of the face subsided.

THE FACIAL.

The next nerve which demands notice is the portio dura of the seventh or facial.

That this nerve is in part for voluntary motion cannot be doubted, but we shall see that there is also strong evidence for its being a nerve of sympathy likewise.

This nerve is not distributed in animals in proportion to the voluntary power possessed over organs endowed by it, but according to the sympathetic action of these parts.

In birds, we find a facial which, instead of supplying the bill, a part incapable of expression, turns over and is distributed on the back of the neck, the most expressive part in a bird, as the bristling of the feathers in the neck of an excited game-cock fully proves, and a part abundantly supplied with ordinary nerves from other sources. It is developed in different species in proportion

to their power of expression. In the duck, it is as small as a cambric thread, while in the cock it is large;* and that this is the nerve which enables the bird to express emotion, was proved by Shaw, who divided it in a game-cock, and found that the bird after its division, on being confronted with its antagonist, could not erect its neck feathers, or assume the fierce look it displayed before the operation.

It is very largely distributed to the lips of the horse and camel. It is found to be much larger in all the rapacious tribes, and gives to some of them a power of expression in which the herbaceous are much inferior. It is by this nerve, probably, that the eye of the wolf is lighted up, so as to give it that power of fascination which it is described as possessing. This nerve is much larger in man than any other animal. The monkey, lion, dog, camel, horse, and ass, follow in order of development.

There have been many experiments made upon this nerve, the result of which is, that after its division expression in the countenance is entirely lost, and that stimuli applied to the parts it supplies no longer excite their usual sympathetic actions. For the first phenomenon, the supposi-

* Bell on the Nerves.

tion that the nerve is merely voluntary may in some measure account; for the second it cannot.

In a monkey and dog in which Sir C. Bell divided this nerve, expression wholly vanished from the side of the face which had received the injury; when irritated, the terrier could only, by twisting his jaw, throw a sinister expression into his countenance. The brilliancy of the eye was gone. This last observation is very important, as there is no voluntary power over the expression of the eye-ball, and "is of peculiar value," as Dr Fletcher observes, "as demonstrating the influence of this nerve, and therefore, probably, of all the nerves of this system, on the capillary vessels the seat of all the molecular changes in the body."

When carbonate of ammonia was applied to the nostrils of an ass, after the division of the portio dura of one side, while the sound side curled up as in sneezing, the injured one remained unaffected. No such effect followed the division of the olfactory,* or the paralysis of the fifth.† There is a case mentioned, on the authority of Prevost, of a man in the hospital of Montpellier, who had his facial nerve divided by a sabre cut,

* Magendie. † Bell.

which in a great measure checked the secretion of saliva.*

It is through the agency of this nerve that the features acquire such a peculiar expression in disease, that it is even said we can form a pretty accurate idea of its severity by the state of the nostrils.† The action of the passions on the nostrils is very conspicuous, their expansion in hilarity,‡ and the pinched appearance they assume in grief.

The effect of a wound on the diaphragm is very remarkable, as occasioning the risus sardonicus; thus returning, as it were, by the same set of nerves an impression to a part from which it so frequently receives one.

There are a great number of exceedingly interesting cases of paralysis of this nerve, given in the Appendix to Sir C. Bell's work on the Nerves; but as such cases are now familiar to the profession, and as in almost all of them voluntary as well as sympathetic motion of the face was lost, it

* Brachet, Op. cit. p. 272.

† Desmoulins and Magendie.

‡ This has not been overlooked by the most accurate observer of mankind who ever wrote:

"Now set the teeth, and *stretch the nostril wide,*
Hold hard the breath, and bend up every spirit to his full height." *Henry V.*

will be unnecessary to quote any one except the following, in which it seemed that the respiratory motion alone was arrested, while the voluntary remained unimpaired. It is from "Descot sur les Affections locales des Nerfs," and is as follows. In operating upon a tumour about the right parotid, the facial of that side was cut. The right side became paralysed, but the paralysis appeared in the movements of respiration and speech alone; in all other cases it was scarcely perceptible.*

There is also another very interesting case† of a girl affected with partial paralysis of the side of the face, and partial blindness, from dropping of the eyelid, which greatly improved when she was excited, although even then she had not the voluntary power over them. There is a case of hemiplegia mentioned by Dr Kennedy,‡ in which there was paralysis of all the muscles on the left side, except those supplied by the portio dura, while there was paralysis of that nerve on the other side.

"It is a happy idea," says Serres,§ "which considers the portio dura as the respiratory nerve of the face. I have often had occasion to ob-

* Bell. † Bell, p. 375.

‡ Dublin Journal, vol. x. p. 434.

§ Anatomie Comp. du Cerveau, p. 455.

serve in paralytics the effects related by Shaw and Bell."

The spasmodic actions which this nerve produces in the face, are usually in unison with those which occur in the other respiratory muscles. Affections of the organs supplied by this nerve frequently give rise to sympathetic action of other respiratory muscles, as in the following case:—"A lady was liable to fits of incessant sneezing, attended with a most abundant flow of watery fluid from the nostrils. This sometimes alternated with a nervous cough, while not unfrequently she suffered under that sensation in the throat called globus hystericus."* Another very well marked case, illustrative of the intimate connection maintained between the muscles of the face and other respiratory organs, will be found in Sir C. Bell's Appendix to his book, p. 412.

THE PATHETIC.

This is a very remarkable nerve. It is said to exist in all tribes of animals. In fishes it is large, for, as they are not provided with eyelids, they require some means to enable them to brush offending matters from the eyeball. This is done by its being turned inwards and upwards by the

* Brodie on Local Nervous Disorders, p. 61.

action of the trochlearis, which is supplied by this nerve. In the mud crab, the action of this muscle will roll the eyeball over the tuft of hair provided to clear off the adhering matter.*

In man it arises from that portion of the process extending from the cerebellum to the testes, to which the valve of Vieussens is attached.† It threads its course through the numerous nerves of the orbit, without interchanging any filaments except with the fifth; and, after giving off a branch to the lachrymal gland, terminates in the superior oblique muscle or trochlearis. This distribution is very remarkable to a muscle which certainly greatly affects the expression of the eye, and to the gland which, of all others, is most under the influence of passion. Direct experiments have not been performed on the nerve itself, but Sir C. Bell cut the trochlearis, and found that, while the voluntary motions of the eye were not affected at all, the involuntary were wholly arrested. On holding open the eyes of the monkey that had sustained this injury, and waving his hand before them, the sound eye turned upwards, while the other scarcely moved in that direction. There are many cases illustrating the fact, that the eye is turned upwards

* Bell. † Swan's Plates of the Nerves.

and inwards during sleep, and, indeed, every time we wink;* and the experiments of Sir C. Bell shew that this is affected by the inferior oblique muscle which antagonizes the trochlearis. The action of this nerve and muscle may perhaps be thus explained. The eyeball, when unexcited, is turned upwards and inwards. The moment, however, the eyelids are raised, a stimulus is immediately propagated by sympathy along the pathetic, and the trochlearis acts. Thus, the eyeball is rolled down from a position in which the voluntary muscles cannot easily affect it, and is put in gear as it were.

This rolling upwards is of great consequence in clearing the surface of the cornea of foreign bodies, while, at the same time, by means probably of the lachrymal branch of the nerve, there

* It is but fair to observe, that Sir David Brewster denies this (Edin. Journal of Science, 1825). His arguments are by no means sufficient, however, to overthrow those derived from direct experiment. One of them is derived from the spectrum not changing its position when we close the eye as it does when we press upon it; but in the first case, the point of the retina excited by the ray of light which gives the impression of vision, does not change its relation to the humours of the eye. In the other case, the refracting media are deranged, the ray falls on a different point, the impression is referred to the extremity of the ray, and the position of the object is changed.

is a secretion of tears poured out, which washes the offending matter away.*

THE PHRENIC.

This nerve at its origin cannot be separated from the regular moto-sensitive nerves. It supplies the diaphragm, and cutting it, paralyzes that muscle. But, as the diaphragm may in part be voluntary, the experiment is not conclusive.

But if this nerve be merely voluntary, how the diaphragm can continue to act in coma, catalepsy, paraplegia, and many other states of the system, is a difficulty much greater than any which the admission of its being respiratory will raise. Indeed, of all the muscles holding a mid-way station between those of animal and of organic life, this seems best entitled to a respiratory or sympathetic nerve, being both the "primum suliens" and "ultimum moriens" of muscles not wholly involuntary.

The effect of irritants applied to the nostrils of those who have been drowned or are in a faint, the sudden sobs, and frequent sighs,† when the

* This affords another example of a respiratory nerve influencing capillary action.

† A gasp, a sob, * * * * * * *
A sigh, and nothing more.
BYRON.

person gives no indication of sensation, far less of volition, might convince us that the diaphragm acts involuntarily, and, therefore, that the phrenic nerve is not voluntary, but belongs to the respiratory system.*

THE EXTERNAL RESPIRATORY.†

It is doubtful whether this nerve can be separated at its roots from the regular nerves. It receives filaments from the phrenic, and then passes down to supply the serratus magnus—a respiratory, and, as Stromeyer thinks, involuntary muscle.

* The following case, of affection of the phrenic apparently, is given by Hoadly :—" A workman fell from the roof of a house, and lighted upon his buttocks. He escaped without either dislocation or fracture, but sadly bruised. He had very violent fits of sneezing, but could not sigh. He had likewise great difficulty of breathing performed by the ribs alone."—Hoadly on Respiration.

† The following remarkable case of affection of this nerve was mentioned to me by Mr Mackenzie, anatomical demonstrator, Edinburgh University. A man, æt. 72, after indulging freely at supper, was attacked with vomiting, headach, &c. These were soon followed by severe and incessant hiccough, which had lasted seven days when Mr M. saw him; he was then delirious, and suffering under dyspnœa. Mr M. observed a tumour on the left side over the serratus, into which he plunged a lancet, and evacuated a basin full of pus; the hiccough instantly ceased. On examination he found, that the whole course of the external respiratory nerve was engaged in the abscess. The man soon quite recovered, and is now alive and well.

CHAPTER IV.

GENERAL AFFECTIONS OF THIS SYSTEM.

There are some very curious cases on record of permanent or partial palsy of this system of nerves. As an example of permanent palsy, there is a case related by Sir C. Bell of a man whose breathing ceased the moment he fell asleep, so that he awoke the next instant from the feeling of asphyxia. When sleep began to overpower him respiration became slow, the pulse fell, and the heart's action even ceased.

Such would be our condition if Mr Mayo's opinion, that respiration is entirely voluntary, were correct, and sleeplessness or death would be a nightly alternative.

A temporary affection of the same kind was experienced by Mr Hunter, as related in his life. After having taken some laudanum, gtt. xxx. it is stated, "While he was walking about the room he cast his eyes upon the looking-glass, and observed his countenance to be pale, his lips white, giving the appearance of a dead man. This alarmed him, and led him to feel for his pulse, but he found

none in either wrist; he now thought his complaint serious. Several physicians of his acquaintance were sent for, Dr W. Hunter, &c. . . . . all came, but could find no pulse; the pain still continued, but he found himself at times not breathing. Being afraid of death soon taking place if he did not breathe, he produced the voluntary act of breathing by working his lungs by the power of the will; the sensitive principle with all its effects on the machine not being in the least affected by the complaint. In this state he continued for three quarters of an hour, in which time frequent attempts were made to feel the pulse, but in vain; however, at last the pain lessened, and the pulse returned, although at first but faintly, and the involuntary breathing began to take place."* Of a somewhat similar kind seems to have been the affection of Seneca, thus related in his own words, as translated by Dr Parry:† "Disease has given me a long furlough . . . Of what kind? you say . . . . It may properly enough be denominated sighing, the attack is very short, and like a storm; it usually ends within an hour. To have any other malady is only to be sick; to have this is to be dying. At length by degrees that sighing, which by this time has

* Hunter on the Blood, p. xlvi. 4to edition.

† Dr Parry on Syncope Anginosa, &c. p. 35.

begun to change into common breathing, has returned at longer intervals, and become slower and disappeared. But even now, though it has ceased, my breathing is not natural. It seems to be attended with a sort of hesitation and delay. Be it as it will, provided I do not sigh from the heart."

Asthma may perhaps be also included in affections depending upon temporary paralysis of some of these nerves; and the order in which the symptoms occur, render this opinion highly probable.

"There is first dyspepsia for some time; probably from diminished stimulus to the stomach, attended with eructations of wind and water. The attack comes on usually before midnight; inspiration is performed with great difficulty, the diaphragm never seems to descend sufficiently. There is now a great desire for air."* These symptoms are very similar to those observed in animals, after the division of the par vagum, and it is remarkable that galvanism, which relieves animals after this operation,† should be found so beneficial in asthma. There is afterwards a very copious secretion of mucus poured into the lungs, and much consequent expectoration. In animals, after this operation, so much mucus is found in the lungs as to have led some to assign that as

* Bree on Asthma. † Brachet and M. Edwards, Op. cit.

the cause of death.* After the par vagum has suffered, the other nerves of the respiratory system seem also to become affected, and the patient has to act with them voluntarily; and laying hold of some object above him, he throws into action all the muscles which pass between the shoulders and chest. This may in part account for the permanent high shoulders that distinguish an asthmatic patient, as it is only voluntary actions that come under the law of habit.

The Laryngismus Stridulus of Dr Ley may likewise belong to this class of affections. He supposes it to depend upon the pressure of glands upon the par vagum; but it seems more probable that it is from sympathetic irritation of other parts affecting the muscles of the larynx. The irritation of the gums in teething seems a common cause. Whether hooping-cough may likewise be an affection of this system, is also worthy of consideration. The hooping of an individual who gets a blow on the stomach, is strikingly similar to that in pertussis. The acid vomiting, and the feeling of breathless uneasiness before the fit, might be explained on this hypothesis.

We have now concluded the evidence in favour of this system, and shall briefly consider the objections which have been urged against it.

* Brachet.

CHAPTER V.

OBJECTIONS.

The first which meets us is, *that the respiratory system is of such limited distribution as not to be sufficient to account for general sympathy.* We have before observed that it becomes intimately connected with the ganglionic system. Into the arguments for the universal distribution of this system, we cannot enter. It may be enough to observe, that the researches of Willis and Lobstein and Swan support this view as regards man, and that it is admitted by Grant, Carus, &c. to be true with respect to the inferior tribes. So that we may conclude, with Dr Wilson Philip, that "every organ of the body, with few exceptions, is supplied by ganglionic nerves."* And we may observe, that while Dr Elliotson† enters very fully into all the objections against the views advocated in this essay, he admits as probable the universal distribution of the respiratory system. It would

* Gulstonian Lectures, 1835.

† Outlines of Physiology, Part I.

be unnecessary to enter into any arguments to refute Dr Elliotson's other objections, as it would be merely recapitulating what we have already stated, for they have all been incidentally referred to, and his opinion that the ganglionic system is for sympathy more fully considered, so we shall proceed to consider the objections urged by Dr Alison, and contained in the 2d volume of the Edinburgh Medico-Chirurgical Transactions. It is there observed, *that we may see how much respiration is dependent on sensation by watching the effect of an exciting piece of oratory, the breathless silence with which we listen, as if "we forgot to breathe," except at the intervals of its delivery.* In reply we would remark, in the first place, that the emotion we feel is suspense, a depressing, not an exciting one. Now, as we know that an exciting emotion will call into action muscles in a state of paralysis,* by throwing a new stimulus into them, may we not fairly presume that a depressing emotion, by withdrawing a stimulus, may so derange the function of the lungs, that the changes usually effected there, and necessary for the excitement of this *sympathetic motion*, may not so readily take place, while the want of such changes in the air and blood may

* Bell on the Nerves, Appendix.

produce *uneasy sensations*, which we overlook when occupied, and which prompt a desire to breathe when our interest subsides.

It is again objected, *that it is not every impression made upon a sensitive part concerned in any such action which is followed by a change in a different part, but only those which excite a particular sensation.*

But, in reply, it may be asked, why may not a particular irritation, which gives rise to a particular sensation, likewise give rise to a particular sympathetic action?

3d, *Many of the sympathetic actions are produced between parts supplied by nerves which do not arise near each other.*

This part of the doctrine does not seem to be received in the light its author wished, for it is not for accidental connections of nerves in their course as accounting for sympathetic action that he argued; but that there is a system of nerves diffused generally through the frame, that wherever an impression is made, they might take cognizance of it, and convey it, not merely to the first inosculating branch from the part to be affected by it, but invariably back to the centre at the respiratory tract, thence to be conveyed by respiratory nerves to its destination; and, as a

stimulus acts only on the organs, the particular susceptibility of which is adapted to its influence, for instance, as mercury produces precisely similar effects on similar parts, whether it be introduced into the system by means of friction on the thighs or absorption from the stomach, whatever mode of introduction we select, it acts with equal certainty upon the bones, throat, and salivary glands, so in like manner the stimulus of sympathy may be carried along all the respiratory nerves, but its effects be exhibited by those organs alone, the peculiar susceptibility of which adapts them to its influence, although no part is left unsolicited.

4th, *There are many instances of nerves closely connected at their origin, the parts supplied by which shew no tendency to sympathize.* The mere connexion at their origin is not supposed to be sufficient, the nerves themselves must be specially adapted for the conveyance of sympathy, and the organs they supply must be endowed with a susceptibility of being mutually impressed by the actions of one another.

5th, *That various sensations derived from smell affect the system differently, as a nauseating follows one, and a sense of exhilaration another. Therefore* (it is argued), *we should require a different*

nervous filament, to convey each particular character of odour, that it might produce a different effect upon the system. But it is with the mental sensation that the stomach sympathizes, and not with the impression made by the odour on the nose; and we know that various as are the effects of sound, one pleasant, and another painful, as one sight is grateful, another revolting, yet that each affects the mind through the medium of the nerve provided for conveying all the impressions of that sense. In like manner, there seems no greater difficulty in understanding how various effects should be produced on the body by one set of nerves, than how such various mental emotions should be excited in the mind by the agency of a single nerve.

6th, *In coma vomiting, a sympathetic action cannot be produced by tickling the fauces.*

That many sympathetic actions should be arrested in coma is not wonderful, but that their arrest depends upon the absence of sensation, is not yet proven. But respiration, a sympathetic action, seems not to be interrupted in coma; surely then *it* cannot depend upon sensation, as the whole force of this argument hinges upon its absence?

CONCLUSIONS.

We feel entitled, from the foregoing facts and arguments, to conclude,

1st, That sympathy is maintained through the medium of nervous matter.

2d, That this sympathy is probably not maintained by the ganglionic system of nerves.

3d, That the reflex action in the moto-sensitive nerves does not account for it.

4th, That there is a special system of nerves for its conveyance distinct from the systems of voluntary motion and sensation.

5th, That in this system of sympathetic nerves we may certainly place the par vagum, spinal accessory, facial, and phrenic, probably the pathetic and inferior respiratory, and possibly the glossopharyngeal.